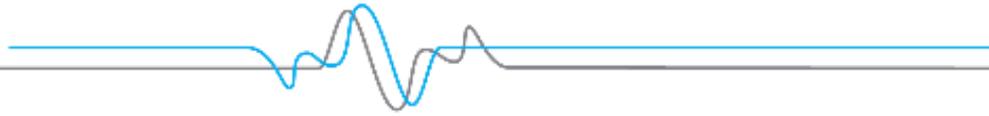


TDECQ vs capture bandwidth

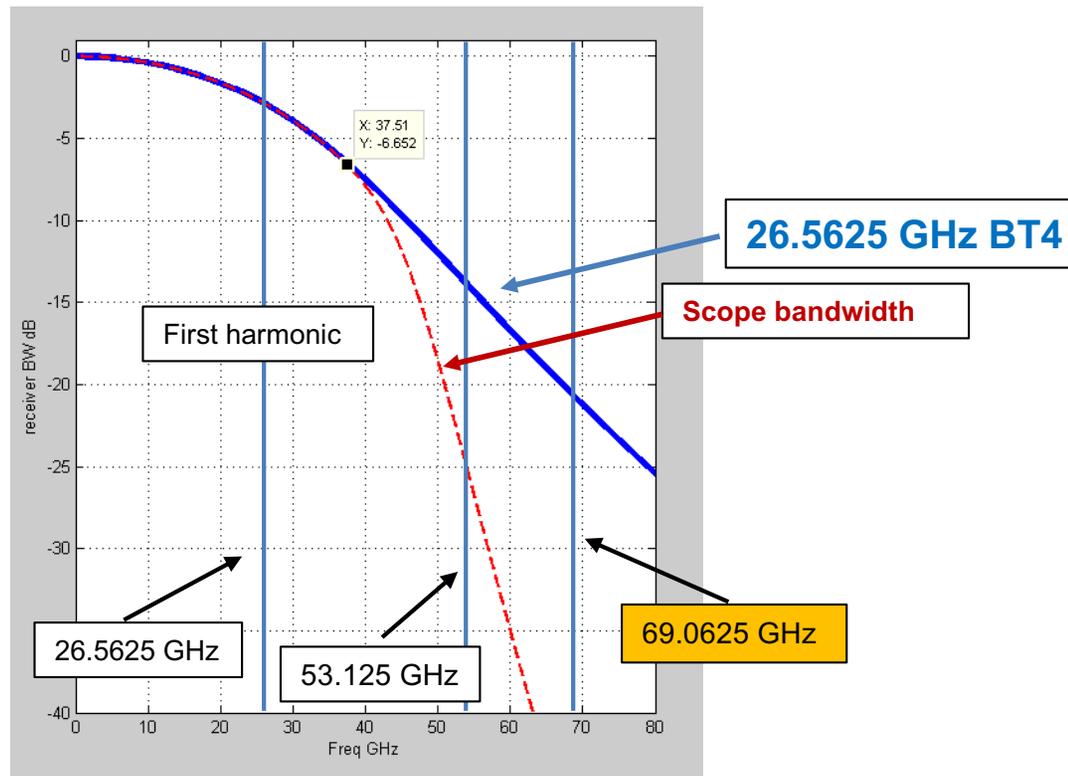
Kees Propstra





Introduction

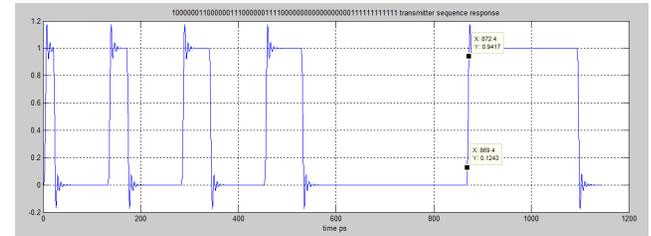
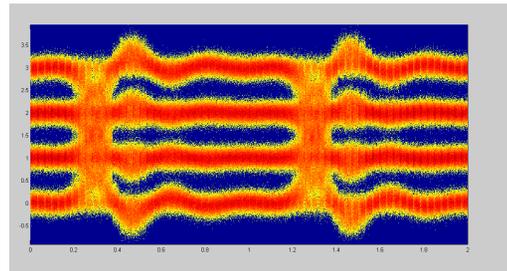
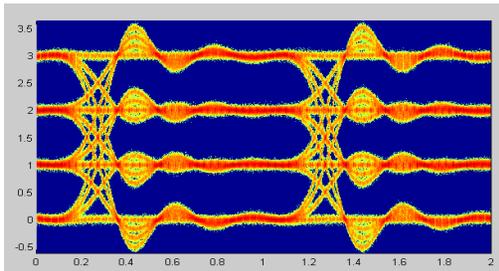
Current proposed required TDECQ capture bandwidth is very high (up to 1.3 x 53.125 GHz) which seems to contradict realistic frequency content in high speed signals (especially in optics and after BT4 filter already applied).



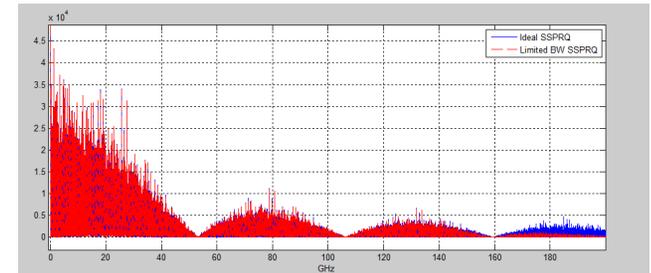


Experiment (Simulation)

- **High spectral content 53.125 Gbaud PAM4 SSPRQ signal**
 - Rise/fall time 10-90% ~3 ps (much faster than real transmitter)
 - Ringing and overshoot
 - add noise to target TDECQ 3.2 dB



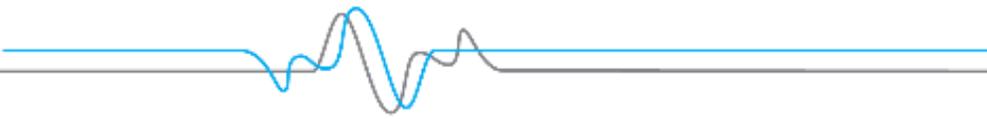
- **26.5625 GHz BT4 filter**



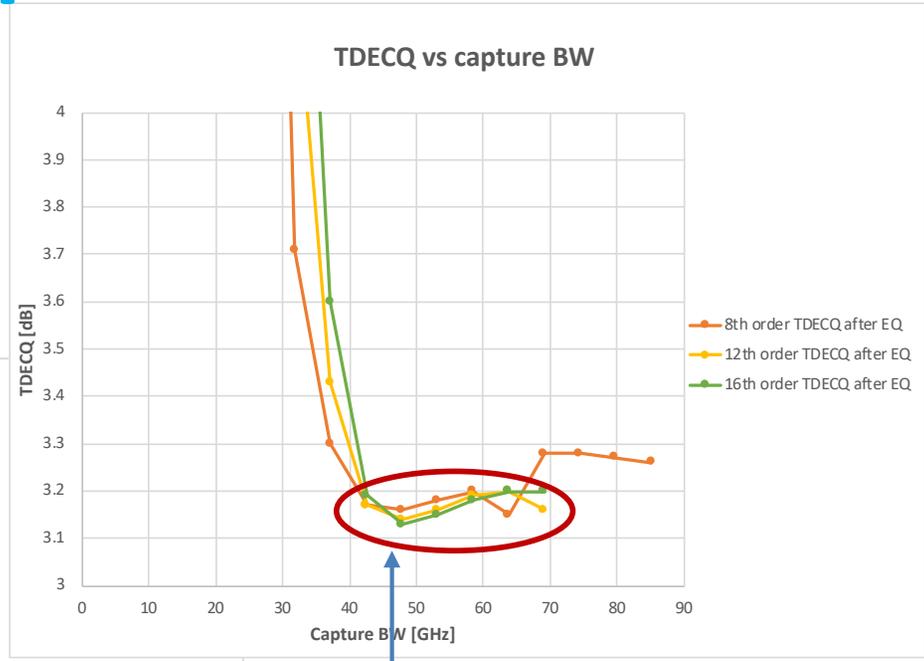
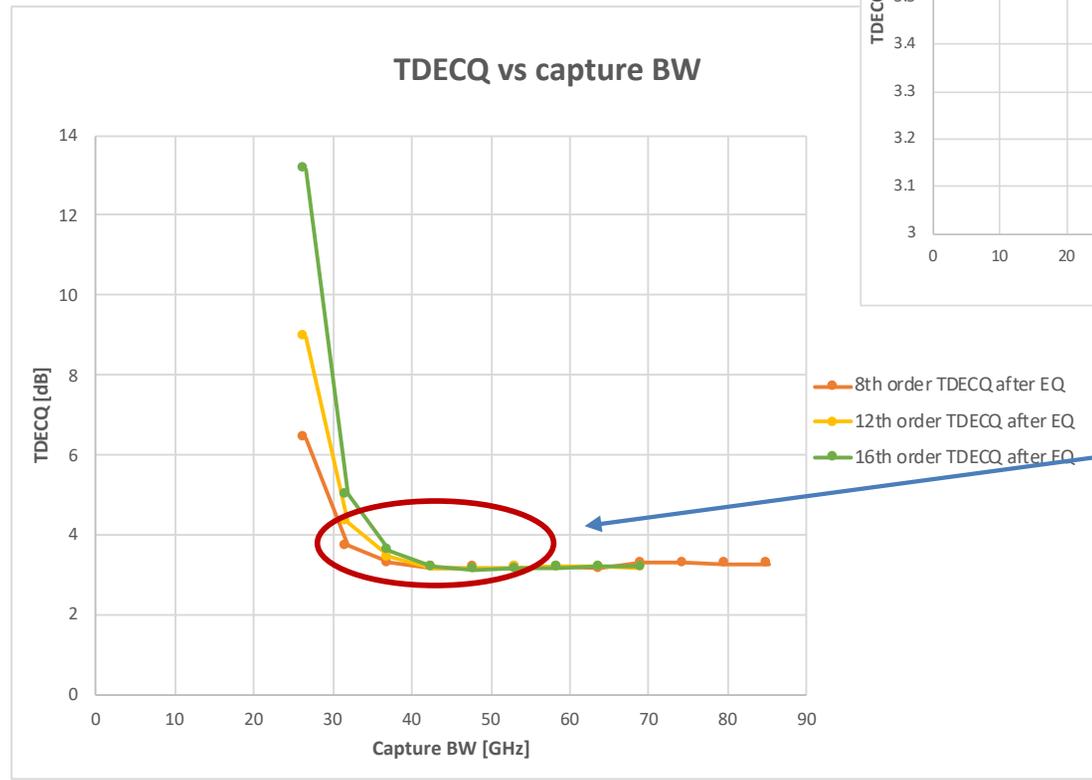
Measure parameter that predicts link BER & performance

TDECQ was simulated as a function of the capture bandwidth

- Brick wall was simulated by an 8th and higher order Butterworth low pass filter
- Evaluate steeper roll-offs/phase



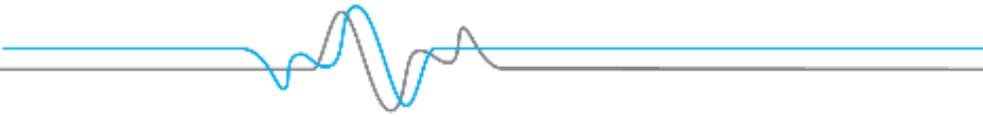
TDECQ vs capture bandwidth



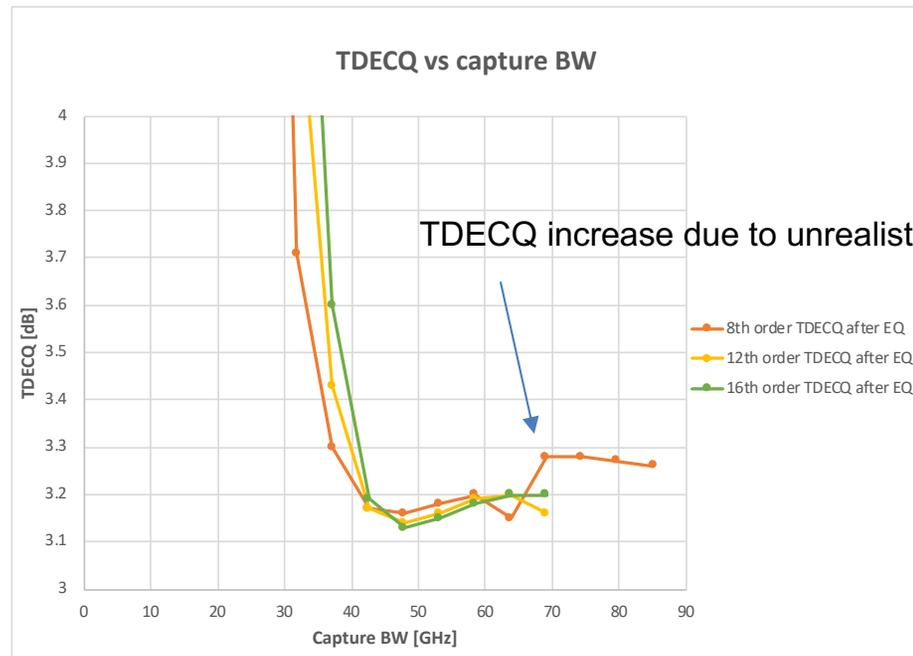
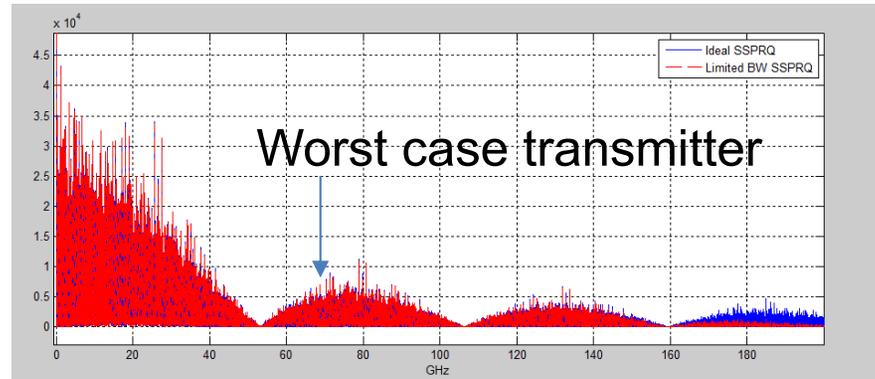
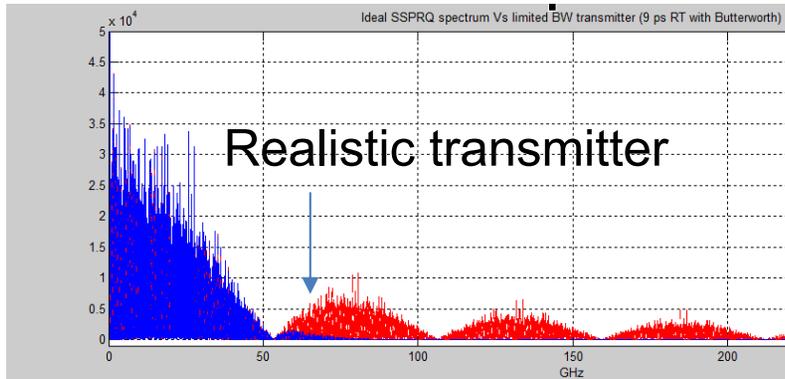
Convergence to final TDECQ value

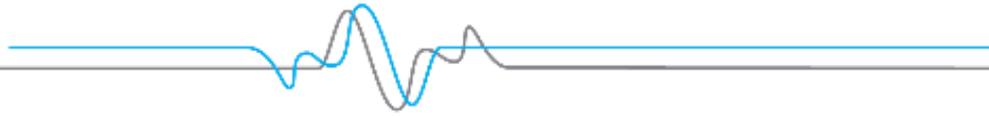
- error < 0.1 dB @ 42.5 GHz
- order of roll-off has no significant impact

Worst Case Tx



TDECQ vs capture bandwidth





TDECQ vs capture bandwidth

Conclusion & Proposal:

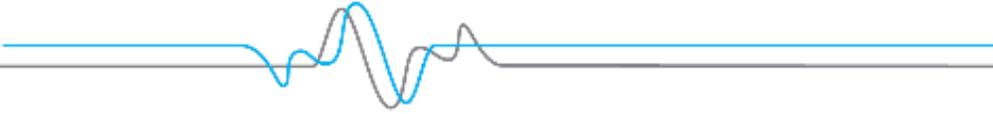
A TDECQ error of less than 0.1 dB can be achieved by a capture bandwidth of 42.5 GHz / 80 % of the Baudrate.*

3.4 proposal:

The combination of the O/E converter and the oscilloscope has a fourth-order Bessel-Thomson filter response with a bandwidth of approximately 26.5625 GHz to at least 0.80×53.125 GHz and at frequencies above 0.80×53.125 GHz the response should not exceed -9 dB.

Compensation may be made for any deviation from an ideal fourth-order Bessel-Thomson response.

* This data is consistent with the observed TDECQ delta of ~ 0.5 dB at capture bandwidth change of 65 to 68% (http://www.ieee802.org/3/cd/public/May18/zivny_3cd_01c_0518.pdf)



Proposal for 8023cd_D3p4

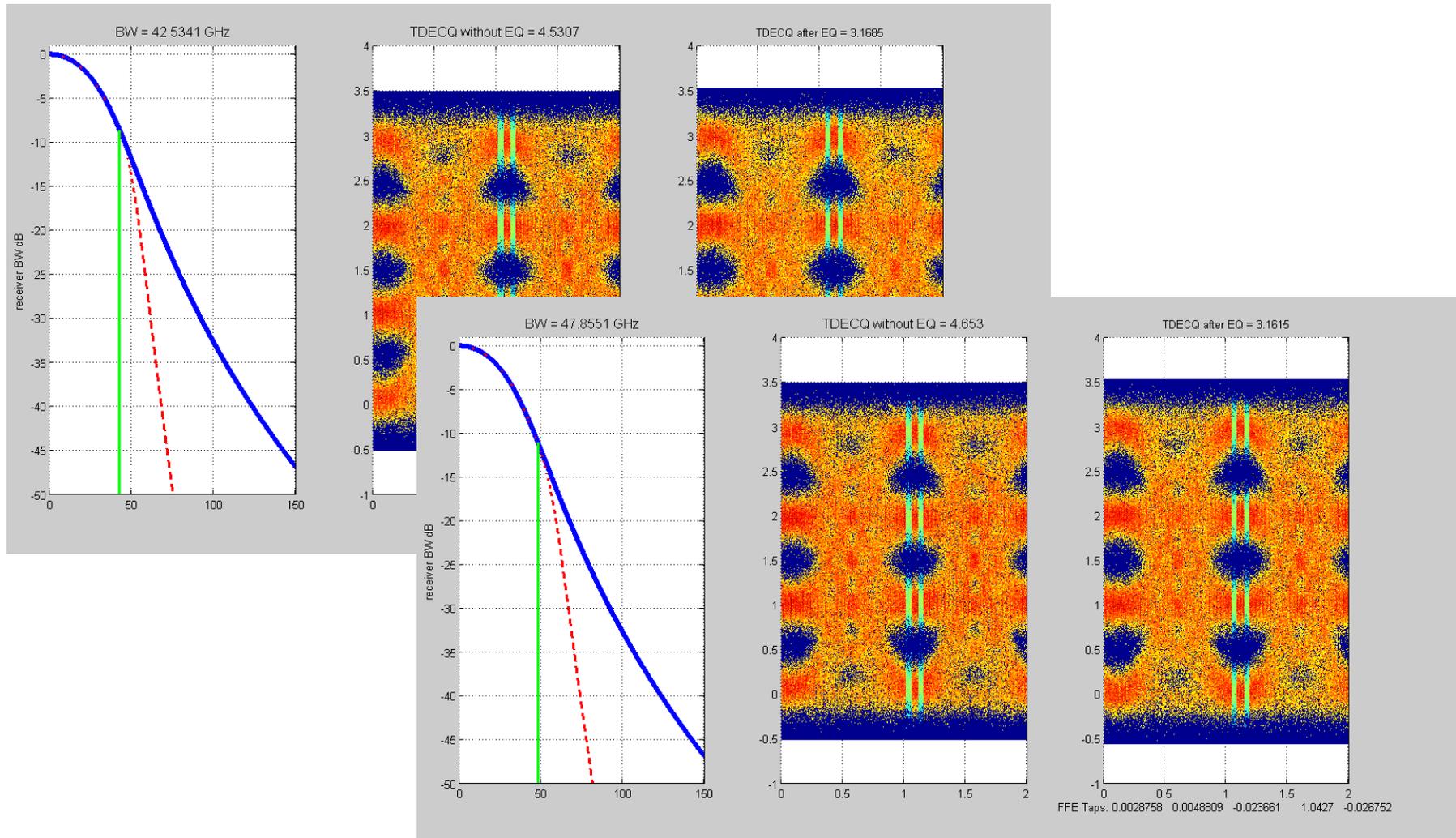
140.7.5 Transmitter and dispersion eye closure for PAM4 (TDECQ)

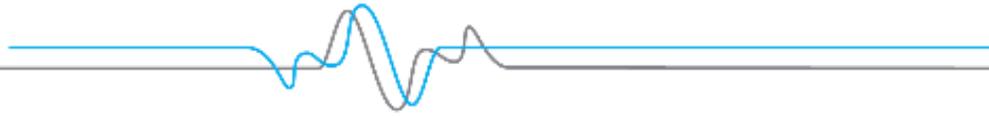
The TDECQ and $TDECQ - 10\log_{10}(C_{eq})$ shall be within the limits given in Table 140–6 if measured using the methods specified in 121.8.5.1, 121.8.5.2, and 121.8.5.3 using a reference equalizer as described in 140.7.5.1, with the following exceptions:

- The optical return loss of the transmitter compliance channel is 15.5 dB.
- The signaling rate of the test pattern generator is as given in Table 140–6 and uses a test pattern specified for TDECQ in Table 140–10.
- There are no interfering optical lanes and therefore the delay requirement of at least 31 UI between test pattern on one lane and any other lane, as specified in 121.8.5.1, is redundant.
- The combination of the O/E converter and the oscilloscope has a fourth-order Bessel-Thomson filter response with a bandwidth of approximately 26.5625 GHz to at least 1.3×53.125 GHz and at frequencies above 1.3×53.125 GHz the response should not exceed –20 dB.
- The normalized noise power density spectrum, $N(f)$ in Equation (121–9), is filtered by a fourth-order Bessel-Thomson response filter with a bandwidth
- P_{th1} , P_{th2} , and P_{th3} are varied from their nominal values by up to $\pm 1\%$ of OMA_{outer} in order to optimize TDECQ. The same three thresholds are used for both the left and the right histogram.

Replace with proposal on previous page

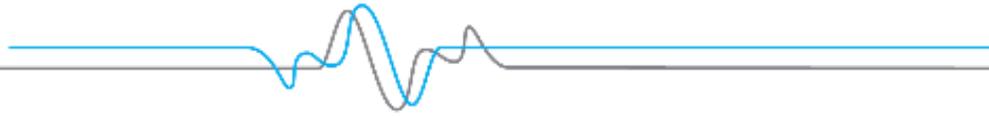
TDECQ vs capture bandwidth Data





Background





Proposals

140.7.5 Transmitter and dispersion eye closure for PAM4 (TDECQ)

IEEE P802.3cd™/D3.3, 5th June 2018

The combination of the O/E converter and the oscilloscope has a fourth-order Bessel-Thomson filter response with a bandwidth of approximately 26.5625 GHz.

IEEE P802.3cd™/D3.4, 25th July 2018

The combination of the O/E converter and the oscilloscope has a fourth-order Bessel-Thomson filter response with a bandwidth of approximately 26.5625 GHz to at least 1.3×53.125 GHz and at frequencies above 1.3×53.125 GHz the response should not exceed -20 dB.